I. "Letter from W. De La Rue, F.R.S., to Prof. Stokes, Sec. R.S., relative to the Observations taken with the Kew Heliograph."

The Observatory, Cranford, Middlesex, W.,
February 5th, 1872.

My dear Sir,—I beg herewith to hand you a statement of the expenditure of the £200 I received in February 1871 from the Government-Grant Fund for working the Kew heliograph and measuring and reducing the photographic pictures from February 1st, 1871, to January 30, 1872. I enclose the vouchers.

The work which I undertook to superintend during the last ten years has been brought to a close, so far as the observations are concerned. It has, however, been impossible to keep up the measurements of the sun-pictures and their reduction to the day. Indeed it will take eighteen months to bring these to a close; I have agreed with Mrs. Whipple (formerly Miss Beckley) and Mr. Loewy to complete this work for a specific sum (£170). As the funds placed at my disposal are exhausted, I will defray this expense myself.

It may be of interest to the Government-Grant Committee to know that, during the ten years (1862, February, to the end of January 1871), 2778 pictures have been obtained on 1724 days.

Since the Kew instrument was devised and constructed, I have been able, with the aid of Mr. Dalmeyer, to introduce many improvements, both in the mechanical parts and the optical portion of the instrument; but I did not think it desirable to interrupt the sun-work to make any changes in the Kew heliograph. Now that the work is completed, I would recommend that the secondary magnifier should be changed to the form adopted in the instrument made for the Russian Government, under my direction, and now at work at Wilna, by which very much better pictures are obtained than those procured at Kew. The cost of this change would be about £30.

II. "On the Organization of the Fossil Plants of the Coal-measures.—Part III. *Lycopodiaceæ*." By W. C. Williamson, F.R.S., Professor of Natural History in Owen's College, Manchester. Received February 29, 1872.

(Abstract.)

An outline of the subject of this memoir has already been published in the Proceedings* in a letter to Dr. Sharpey. In a former memoir the author described the structure of a series of Lepidodendroid stems, apparently belonging to different genera and species. He now describes a very similar series, but all of which, there is strong reason for believing, belong

* *Suprà*, p. 95.

to the same plant, of which the structure has varied at different stages of its growth. The specimens were obtained from some thin fossiliferous deposits discovered by Mr. G. Grieve of Burntisland, in Fifeshire, where they occur imbedded in igneous rocks. The examples vary from the very youngest, half-developed twigs, not more than $\frac{1}{12}$ of an inch in diameter, to arborescent stems having a circumference of from two to three feet. The youngest twigs are composed of ordinary parenchyma, and the imperfectly developed leaves which clothe them externally have the same structure. In the interior of the twig there is a single bundle, consisting of a limited number of barred vessels. In the centre of the bundle there can always be detected a small amount of primitive cellular tissue, which is a rudimentary pith. As the twig expanded into a branch, this central pith enlarged by multiplication of its cells, and the vascular bundle in like manner increased in size through a corresponding increase in the number of its vessels. The latter structure thus became converted into the vascular cylinder, so common amongst Lepidodendroid plants, in transverse sections of which the vessels do not appear arranged in radiating series. Simultaneously with these changes the thick parenchymatous outer layer becomes differentiated. At first but two layers can be distinguished—a thin inner one, in which the cells have square ends, and are disposed in irregular vertical columns, and a thicker outer one consisting of parenchyma, the same as the epidermal layer of the author's preceding memoir. In a short time a third layer was developed between these two.

When the vascular cylinder had undergone a considerable increase in its size and in the number of its vessels, a new element made its appearance. An exogenous growth of vessels took place in a cambium layer, which invested the preexisting vascular cylinder. The author distinguishes the latter as the vascular medullary cylinder, and the former as the ligneous zone. The newly added vessels were arranged in radiating laminæ, separated from each other by small but very distinct medullary rays. At an earlier stage of growth traces of vascular bundles proceeding from the central cylinder to the leaves had been detected. These are now very clearly seen to leave the surface of the medullary vascular cylinder where it and the ligneous zone are in mutual contact; hence tangential sections of the former exhibit no traces of these bundles, but similar sections of the ligneous zone present them at regular intervals and in quincuncial order. Each bundle passes outwards through the ligneous zone, imbedded in a cellular mass, which corresponds, alike in its origin and in its direction, with the ordinary medullary rays, differing from them only in its larger dimensions. At this stage of growth the plant is obviously identical with the *Diploxylon* of Corda, with the *Anabathra* of Witham, and, so far as this internal axis is concerned, with the *Sigillaria elegans* of Brongniart. The peculiar medullary vascular cylinder existing in all these plants is now shown to be merely the developed vascular bundle of ordinary Lycopods, whilst the exogenous radiating ligneous zone enclosing

that cylinder is an additional element which has no counterpart amongst the living forms of this group.

Though the central compound cellulo-vascular axis continued to increase in size with the general growth of the plant, it was always small in proportion to the size of the stem. The chief enlargement of the latter was due to the growth of the bark, which exhibited three very distinct layers,—an inner one of cells with square ends, and slightly elongated vertically and arranged in irregular vertical rows, an intermediate one of prosenchyma, and an outer one of parenchyma. These conditions became yet further modified in old stems. The exogenous ligneous zone became very thick in proportion to the medullary vascular cylinder, and the differences between the layers of the bark became yet more distinct. These differences became the most marked in the prosenchymatous layer; at its inner surface the cells are prosenchymatous, but towards its exterior they become yet more elongated vertically, their ends being almost square, whilst numbers of them of exactly equal length are arranged in lines radiating from within outwards. These oblong cells often pass into a yet more elongated series with somewhat thickened walls, which become almost vascular, constituting a series of bast-fibres. In the transverse sections these prosenchymatous cells are always arranged, like the vessels of the ligneous zone, in radiating lines. Yet more external is the subepidermal parenchyma passing into leaves composed of the same kind of tissue. The petioles of the leaves have been long, if not permanently, retained in connexion with the stem, a character of Corda's genus *Lomatophloios*.

Where young twigs branch, the vascular medullary cylinder divides longitudinally into two parts; the transverse section of this cylinder now resembles two horse-shoes pointing in opposite directions. The break in the continuity of each half of the cylinder occasioned by the division is never closed by new vessels belonging to the cylinder; but when the stem develops exogenously, the cambium-layer, from which the new growths originated, has endeavoured to surround these openings in the cylinder, and, by closing them, once more to separate the medullary from the cortical tissues. Some beautiful specimens have been obtained, which exhibit these new exogenous layers in process of formation. The vessels or the young layers are not half developed. At first they meander vertically through masses of delicate cellular tissue; but they soon arrange themselves in regular radiating vessels and cells, becoming mere outward prolongations of the woody wedges and medullary rays of the older part of the stem. At this stage of their growth, the walls of the vessels are deeply indented by the contiguous cells, as if the plastic tissues of the former had been moulded upon the latter structures. As the new vessels enlarge, the superfluous intervening cells disappear, until each medullary ray finally consists of a single vertical pile of from one to a small number of cells, arranged as in many Coniferæ. The exceptional cases are those where

vascular bundles pass outwards to the leaves; these bundles have protected the contiguous cells above and below them from the pressure of the enlarging ligneous vessels and limited their absorption. Both these and the smaller ordinary rays pass outwards in horizontal and parallel lines. The evidences of an exogenous mode of growth afforded by these young, half-developed layers of wood is clear and decisive.

The Burntisland deposits are full of fragments of strobili, especially of torn sporangia and of macrospores. Several fine *Lepidostrobi* have been obtained like those to which the fragments have belonged, and which the author believes to have been the fruits of the stems described. The structure of these strobili is very clear and of interest; the primary branches from the central axis subdivide, so that each sporangium rests upon a separate bract, from the upper surface of which a vertical lamina arises, and, extending the entire length of the sporangium, ascends far into its interior, where it bifurcates. The cellular walls of the sporangium blend with the bract along each side of the base of this sporangiophore. The microspores occupy the upper part of the *Lepidostrobus*, and are usually triplospores, sometimes tetraspores. The macrospores occupy the lowermost sporangia, are of large size, and are very remarkable from having their external surfaces clothed with numerous projecting caudate appendages, each one of which is slightly capitate at its extremity. So far as the author is aware, this is an undescribed form of macrospore.

Two new forms of *Lepidodendron* are described from the Oldham beds, in one of which the medullary axis attains to an unusually large size, even in the young shoots; whilst the other is remarkable for the magnitude of its leaves. It is obvious that the plant which is the chief subject of the memoir is a true example of Corda's genus *Diploxylon*, so far as its woody axis is concerned; whilst its bark and leaves are those of a *Lomatophloios*, and its slender twigs are *Lepidodendra*. The author also points out the probability that the plant had a true Stigmarian root.

The structure of these fossil types is compared with that of recent *Lycopodiaceæ*. The vascular medullary cylinder is shown to be an aggregation of the foliar vascular bundles, so that the vascular connexion between the leaves and the stem is maintained exclusively by means of these vessels, which thus correspond most closely with the central vascular axes of living Lycopods. On the other hand, the exogenous layers do not communicate directly with the leaves in any way—but are homologous with the corresponding layers in the Stigmarian root, in which latter they receive the vascular bundles from the rootlets. The medullary cylinder does not enter the roots, but appears to terminate at the base of the stem, though the pith is prolonged through them. Hence it seems probable that the nutritive matters were taken up from the soil by the Stigmarian rootlets, that they ascended into the Diploxyloid stem through the exogenous layer, but that, in order to reach the leaves, if conveyed by the vessels and not by the cellular tissues, they had to be transferred by endosmosis to

those of the medullary cylinder. The bark of the fossil plants is compared with those of *Lycopodium chamæcyparissus* and *Selaginella Martensii*, which two combined represent the former.

These discoveries necessitate some changes in generic nomenclature, since the several parts of the plant not only represent the three genera above mentioned, but also several others. Meanwhile some other errors require correction. Corda erroneously defined his genus *Diploxylon* as having no medullary rays, and Brongniart relied upon this distinction in separating *Diploxylon* from *Sigillaria*; but no difference exists between the ligneous structures of the two genera, so far as *Sigillaria* is illustrated by Brongniart's *S. elegans*. Corda, Brongniart, and King all agree in regarding *Diploxylon* (which is identical with Witham's *Anabathra*) as belonging to the Gymnospermous Exogens. The necessity for abandoning this separation of the plants in question from the *Lycopodiaceæ*, urged in the author's previous memoir, is now made more obvious than before, the distinctions upon which the great French botanist relied in his classification being now shown to be such as mere differences of age can produce. The author concludes from his own observations that the genera *Diploxylon*, *Anabathra*, *Lomatophloios*, and *Leptoxylon* must be united. Brongniart had already brought into one generic group Corda's genera *Lomatophloios*, *Leptoxylon*, and *Calamoxylon*, Göppert's genus *Pachyphyllum*, and Sternberg's genus *Lepidophloios*, giving the latter name to the whole. Hence no less than six obsolete generic names are disposed of. The author finally follows Brongniart in adopting the term *Lepidophloios*, and *temporarily* assigns to the plant described the trivial name of *L. brevifolium*. The further relations of this genus to more ordinary forms of *Lepidodendron* require further investigation.

Much credit is due to G. Grieve, Esq., of Burntisland, for the energy with which he has worked amongst the deposits at Burntisland; and the author acknowledges his great obligations to that gentleman for liberal supplies of specimens for examination.

March 14, 1872.

The EARL OF ROSSE, D.C.L., Vice-President, in the Chair.

The following communications were read:—

I. "Contributions to the History of the Opium Alkaloids.—Part IV." By C. R. A. Wright, D.Sc., Lecturer on Chemistry in St. Mary's Hospital Medical School. Received January 29, 1872.

§ 1. *On the Action of Hydriodic Acid on Morphia in presence of Phosphorus.*

It has been shown in Part III. of these researches* that when hydriodic acid acts on codeia in presence of phosphorus, a series of products are ulti-

* *Suprà*, p. 8.